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REPORT R-1685

UNITED STATES ARMY

FRANKFORD ARSENAL

DEVELOPMENT OF CARTRIDGE, POWDER ACTUATED CUTTER, XM83,
FOR REEFING LINE CUTTER

by

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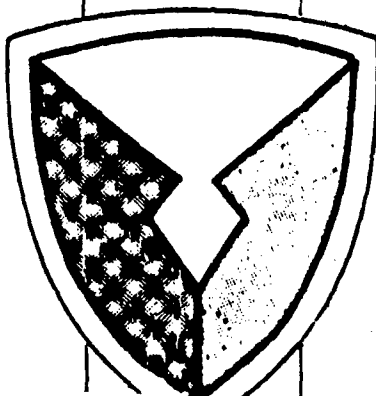
J. M. FARRELL

OMS Code 5110.22.011
AF MIPR 33-616-58-47

June 1963

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REPORT R-1685



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REPORT R-1685

DEVELOPMENT OF CARTRIDGE, POWDER ACTUATED CUTTER, XM83,
FOR REEFING LINE CUTTER

OMS Code 5110.22.011

AF MIPR 33-616-58-47

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June 1963

FOREWORD

The research work described in this report was performed by the Frankford Arsenal, U.S. Army Munitions Command, Philadelphia, Pennsylvania, for the Directorate, Operational Support Engineering, Crew Equipment Division, Parachute Branch, Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio. The work was accomplished under Air Force MIPR 33-616-58-47, Captain R. L. Hester, of the Parachute Branch, ASD, was the project and task engineer. The research program was conducted from August 1958 to May 1960, and was carried out by the Research and Development Group of Frankford Arsenal. The work was performed by J. M. Farrell.

ABSTRACT

Cartridge, Powder Actuated Cutter, XM83, was developed as a replacement for the explosive actuator in the MC-1 reefing line cutter used with heavy duty parachute assemblies. Firing tests demonstrated that this cartridge, loaded with 6 grains of M2 propellant, 2 grains of A4 black powder, and an M29A1 primer, developed the pressure required by the cutter to sever the nylon line specified in requirements.

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INTRODUCTION

In April 1958, the Wright Air Development Division requested the Department of the Army to design, develop, fabricate, and test a cartridge to be used with the TOTCO* Mechanical Initiation Timer (Figure 1) in the MC-1 reefing line cutter for heavy duty parachute assemblies. The cartridge was to replace the T2E5 explosive actuator and the T47 delay assembly currently used in the MC-1 cutter.

DEVELOPMENT

Military Requirements

The following are the principal military requirements; a detailed statement of requirements is given in the Appendix.

1. The cartridge was to be hermetically sealed, was not to protrude beyond the end of the TOTCO timer, and was to be so designed that no modification of the timer would be required.
2. The cartridge was to develop sufficient pressure to cause the blade of the cutter to sever a 2-ply, 6000-pound nylon reefing line.
3. The cartridge was to operate satisfactorily at temperatures of -65° to 200° F.

Design

The development of a cartridge suitable for use with the MC-1 reefing line cutter was limited almost entirely to the selection of the charge. The XM23 cartridge housing is similar to the T295 initiator cartridge, except that it is shorter.

*A proprietary item of the Technical Oil Tool Corp., Los Angeles, Calif.

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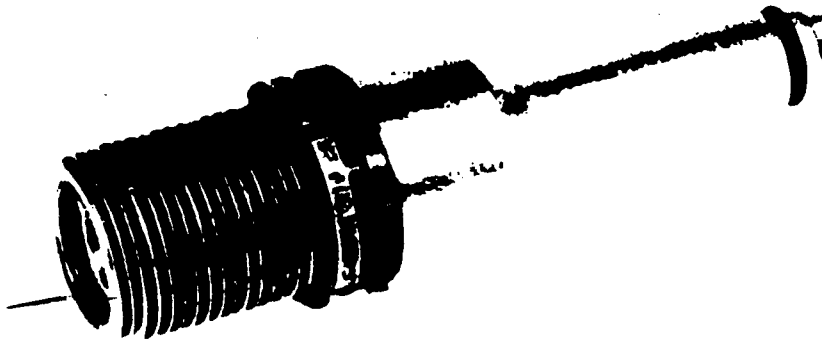


Figure 1. Totco Mechanical Initiation Timer

Operation

The cartridge consists of a case, head, powder, and primer. When the primer is struck by the firing pin, the powder is ignited and the gas pressure, generated against the cutter blade, severs the shear wire, allowing the blade to move forward to cut the nylon reefing line (Figure 2).

TESTING

Preliminary Charge Establishment

To determine the composition and weight of the ballistic charge necessary for proper operation of the cutter, 25 modified T183 cartridges were loaded with different weights of propellant. In some of the preliminary firings, these cartridges were fired in test models which were similar to the MC-1 reefing line cutter except that the body of the cutter had a thicker wall, which enabled the use of a piezo gage to measure pressure; in other firings an MC-1 cutter was used.

Of the ten MC-1 cutters received by Frankford Arsenal, two were assembled with aluminum and eight with brass shear wire. Tests were made; the aluminum wire sheared when a force of 16 pounds was applied, and the brass sheared at 105 pounds. No extra wire was supplied by the Air Force, so an available copper wire which sheared at 110 pounds, was used in the firings. Instrumentation for the firing tests consisted of a piezo gage connected to either an oscilloscope or an oscillograph.

In the first of the three preliminary firing programs, five rounds were fired at ambient temperature. Each round was loaded with five grains of M2 propellant (RAD Lot 9701, with an 0.016-inch web) and an M29A1 primer. In all instances the cartridge case ruptured at the shoulder instead of petalling at the base. The results of these firings follow.

<u>Round</u> <u>No.</u>	<u>Pressure</u> <u>(PSI)</u>	<u>Remarks</u>
1	No instrumentation	Reefing line partially sheared.
2	No instrumentation	Reefing line partially sheared.
3	500	Reefing line partially sheared.
4	500	Reefing line completely sheared.
5	No instrumentation	Reefing line completely sheared.

36.231.S3364/ORD.63



Figure 2. MC-1 Reefing Line Cutter

Substandard T183 cartridge cases were used in the experimental tests, since these cases were readily available. In subsequent firings and final engineering tests, standard XM83 cases were used.

In the second firing program, each of the cartridges was loaded with seven grains of M2 propellant (RAD Lot 9701) and two grains of A4 black powder. An average pressure of approximately 1000 psi was developed in these rounds. The reefing line was sheared cleanly in all rounds. The results of rounds 6 through 10 are given below.

<u>Round No.</u>	<u>Pressure (psi)</u>	<u>Temp (°F)</u>	<u>Position of Reefing Line with respect to Cutter Axis</u>
6	1100	70	Thick cross section perpendicular.
7	1050	70	Thin cross section perpendicular
8	980	70	Thin cross section perpendicular
9	900	-65	Thick cross section perpendicular
10	950	-65	Thin cross section perpendicular.

In the third firing program, which led to the final development of the cartridge, nine rounds, each loaded with six grains of M2 propellant (RAD Lot 9701), two grains of A4 black powder, and an M29A1 primer, were fired. The following tabulation lists the times recorded from actuation of the cartridge to severance of the reefing line, with temperatures and pressures developed.

<u>Round No.</u>	<u>Temp (°F)</u>	<u>Pressure (psi)</u>	<u>Time (msec)</u>
1	70	650	83
2	70	660	82
3	70	640	85
4	-65	580	94
5	-65	590	92
6	-65	560	100
7	200	740	74
8	200	800	70
9	200	790	75

The nineteen rounds fired in the preliminary charge establishment program demonstrated that the copper wire used in tests with the working models sheared when a force of 110 pounds was applied. The brass shear wire supplied with eight of the MC-1 cutters sheared at 105 pounds, and the aluminum shear wire in the MC-1 cutter sheared at 16 pounds.

Final Charge Establishment

On the basis of data obtained in the preliminary firing program, it was concluded that the charge used in the last nine rounds produced the desired operation of the cutter. This charge consisted of six grains of M2 propellant (RAD Lot 9701), two grains of A4 black powder, and an M29A1 primer.

To confirm the adequacy of this charge and to further demonstrate that the cutter would operate satisfactorily with this cartridge (designated XM83), a final firing program was scheduled. In the first of these final firings, conducted after the cartridge had been conditioned to the two extreme temperatures stipulated in the military requirements, an MC-1 cutter was used to determine whether or not the cutter would be distorted by the selected charge. Although the cutter blade complete its stroke in each of the six rounds, the reefing line was not sheared as cleanly as in the working model. Two rounds each were fired at the following temperatures: 200°, -65°, and -90° F; and there was no distortion on any of the units.

The second phase of the final testing program consisted of ten firings. Five rounds were fired with the working model so that pressures could be recorded, and five were fired with the MC-1 cutter. These firings, listed below, were conducted at 70° F.

<u>Round</u> <u>No.</u>		<u>Pressure</u> <u>(psi)</u>
Working Model		
1		720
2		740
3		820
4		740
5	MC-1 cutter	800
6		No instrumentation
7		No instrumentation.
8		No instrumentation.
9		No instrumentation.
10		No instrumentation.

NOTE: Reefing line completely sheared for each round.

By the end of July 1959, samples of the first XM83 cartridge (Figure 3) fabricated were received for analysis. A study of these showed that tolerances were building up in the seal and ring, and that minor revisions were necessary. A month later, 300 cartridges were received for final engineering tests.

Firing and X-raying of these cartridges indicated that the sensitivity of the primers was not within specified limits. Improvements were effected by the manufacturer at this arsenal's request, and a new shipment of primers was received. These were inspected and X-rayed early in 1960.

They were assembled in cartridges, and their sensitivity was then checked in drop tests. The primers proved to be satisfactory. In February the first cartridges were fired in the lot acceptance tests. There was no evidence of cartridge case distortion after these firings.

In the final phase of the charge establishment program, fifty XM83 cartridges were fired in MC-1 reefing line cutters and ten were fired in a working model so that operating pressures could be recorded. Five of these firings were made with the cartridge conditioned to -65° F and five with the cartridge conditioned to 200° F. Ballistic data were not obtained during these tests since no provisions had been made. Table I lists the results obtained with the MC-1 cutter; Table II gives the results obtained with the working model.

TABLE I. Summary of Charge Establishment Firing Test Results Using MC-1 Reefing Line Cutters

<u>Temp</u> <u>(°F)</u>	<u>No. of</u> <u>Rounds</u>
-65	15
70	20
200	15

NOTE: Reefing line completely sheared for each round.

TABLE II. Charge Establishment Firing Test
Results Using Working Model

<u>Round No.</u>	<u>Temp (°F)</u>	<u>Max Pressure (psi)</u>
1	-65	740
2	-65	740
3	-65	760
4	-65	730
5	-65	700
6	200	690
7	200	690
8	200	700
9	200	720
10	200	680

NOTE; Reefing line completely sheared for each round.

QUALIFICATION TESTING

The qualification program for the XM83 cartridge was limited to low and high temperature tests conducted in accordance with Specification MIL-E-5272C.* Altitude, humidity, shock, moisture, and fungus tests were not made because cartridges of a similar design had been tested under these conditions and had been approved. The drop tests were performed to check the sensitivity of the primers. The data recorded met requirements. Locked-shut and no-load tests were not required.

A total of 70 rounds was fired at -65°, 70°, and 200° F to determine satisfactory performance at these temperatures. A summary of the temperature tests is given in Table III.

CONCLUSION

It was concluded that the XM83 cartridge can be used with the MC-1 heavy duty reefing line cutter and the TOIC Mechanical Initiation Timer.

*Environmental explanation.

TABLE III. Qualification (Temperature) Test Results for MC-1 Reefing Line Cutter
Using XM03 Cartridge (Lot FA-RD-1)

Temp (°F)	Maximum Pressure (psi)	Totco Timer Serial No.	Temp (°F)	Maximum Pressure (psi)	Totco Timer Serial No.	Temp (°F)	Maximum Pressure (psi)	Totco Timer Serial No.	Temp (°F)	Maximum Pressure (psi)	Totco Timer Serial No.	Temp (°F)	Maximum Pressure (psi)	Totco Timer Serial No.
-65	740	1001	70	NR*	1034	200	NR*	1001	-90	NR*	1033			
	740	1001		NR	1034		NR	1001		NR	1021			
	760	1001		NR	1034		NR	1001		NR	1029			
	740	1001		NR	1034		NR	1001		NR	1035			
	700	1001		NR	1034		NR	1001		NR	1019			
	NR*	1031		NR	1034		NR	1033		NR	1031			
	NR	1029		NR	1021		NR	1030		NR	1021			
	NR	1023		NR	1029		NR	1019		NR	1035			
	NR	1035		NR	1035		NR	1021		NR	1030			
	NR	1034		NR	1006		NR	1023		NR	1034			
	NR	1021		NR	1005		NR	1033						
	NR	1031		NR	1035		NR	1030						
	NR	1034		NR	1023		NR	1035						
	NR	1030		NR	1033		NR	1029						
	NR	1019		NR	1031		NR	1030						
	NR	1023		NR	1019		NR	1033						
	NR	1019		NR	1021		NR	1034						
	NR	1031		NR	1029		NR	1019						
	NR	1034		NR	1030		NR	1021						
	NR	1020		NR	1034			1023						

*Not recorded

NOTE: Reefing line completely sheared for each round.

RECOMMENDATION

It is recommended that the XM83 cartridge be adopted as a standard item for use with the TOTCO Mechanical Initiation Timer.

APPENDIX

Military Requirements

The Ordnance Corps shall develop the XM83 cartridge and fabricate, test, and furnish to WADD the developed cartridge for reefing line cutting in heavy duty parachute assemblies in accordance with the requirements specified herein.

PART I STATEMENT OF WORK

A. This MIPR provides for the design and development of a cartridge to be used for reefing line cutting in heavy duty parachute assemblies. The developed cartridge shall fulfill the following requirements:

1. Be hermetically sealed.
2. Shall be developed for use with the TOTCO Mechanical Initiation Timer (without modification to the timer) furnished by the Procuring Agency.
3. The cartridge shall not protrude beyond the end of the Initiation Timer.
4. The cartridge shall be capable of actuating at a temperature range of -65° to $+160^{\circ}\text{F}$, a standard reefing line cutter, Air Force Drawing 53B 6140, with sufficient energy to sever a 2-ply, 6000 pound reefing line fabricated from nylon webbing in accordance with Military Specification MIL-W-4088 (USAF), Type XVIII, Condition "U". The high and low temperature requirements shall be in accordance with Procedure I, MIL-E-5272.

5. The cutter assembly including cartridges shall have a performance reliability of not less than +3 sigma based on a confidence level of 95%.

B. The Ordnance Corps shall, as a result of the work accomplished in accordance with Paragraph A above and in accordance with the schedule set forth in Part II hereof, submit the following items:

1. Item I - Conduct final engineering tests and prepare a final letter report for approval by the procuring agency containing all pertinent calculations and test data.
2. Item II - Prepare procurement data in accordance with Frankford Arsenal practice to consist of drawings and specifications for the approved cartridge.
3. Item III - Twelve hundred (1200) each cartridges, Reefing Line Cutting in accordance with data approved under Paragraph A and Item I and II above.

PART II TIME OF PERFORMANCE AND DELIVERY INSTRUCTIONS

A. The Ordnance Corps shall commence work upon acceptance of this MIPR and shall complete all work and delivery of items within five (5) months thereafter.

B. The items required by Part I hereof shall be submitted in accordance with the following schedule:

1. Items I and II shall be submitted within ninety (90) days after receipt and acceptance of this MIPR.
2. Item III - shall be submitted within sixty (6) days after approval of the data submitted under Item I and II.

C. Delivery Instructions

1. Items I and II shall be submitted to:

Commander
Wright Air Development Center
ATTN: WCLEH-4
Wright-Patterson AFB, Ohio

2. Item III shall be submitted to:

Transportation Officer
AFB 2300, Bldg 258
M/F Dept 54, Attn: WCLEH-4
MIPR No. (33-616) 58-47
Wright-Patterson Air Force Base, Ohio

- D. All reports and correspondence submitted shall contain the MIPR Number, Project Number and Task Number designated on the cover page.

PART III ADMINISTRATIVE DATA

- A. All administrative matters pertaining to this MIPR concerning personnel, facilities, contracting, time of performance and terms shall be referred to:

Commander
Wright Air Development Center
ATTN: WCKCP
Wright-Patterson Air Force Base, Ohio

- B. All matters of a technical nature shall be referred to:

Commander
Wright Air Development Center
ATTN: WCLEH-4
Wright-Patterson Air Force Base, Ohio

PART IV ACCEPTANCE

- A. Three (3) copies of the obligating instruments (one certified) resulting from this MIPR shall be forwarded to:
Commander, Wright Air Development Center, ATTN: WCKCP, Contracting Officer for Inter-departmental Procurement, Wright-Patterson Air Force Base, Ohio.

- B. The Aeronautical Accessories Laboratory, WCLEH-1, WADC, WPAFB, Ohio, is hereby designated as the point for final inspection and acceptance by the Air Force for all work called for under this MIPR.

PART V AIR FORCE FURNISHED PROPERTY

The U. S. Air Force shall furnish to the Ordnance Corps for use in connection with this MIPR the Government furnished property listed in subparagraph 1 below and such other property as may be approved by the Contracting Officer subject to the provisions of subparagraph 2 below:

1. a. Ten (10) each TOTCO Initiation Timers.
b. Ten (10) each reefing line cutters and necessary quantity of reefing line for the development.
2. The Air Force shall furnish, for use in connection with the performance of this MIPR, the property described above. Accountability of such property will be transferred to the performing agency. Upon termination or completion of work to be performed, residues of the property shall be returned to the Air Force as the Contracting Officer may direct.

PART VI MIPR CONTENTS

This MIPR consists of DD Form 448, the Schedule consisting of Part I thru VI inclusive on pages A, B and C inclusive and the General Provisions consisting of paragraph 1 thru 6 and 8 thru 11 on pages 1 thru 3 inclusive.

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Philadelphia, Pa 19137
DEVELOPMENT OF CARTRIDGE, POWDER ACTUATED CUTTER, KNS3,
FOR REEFING LINE CUTTER by J. M. Farrell
Report R-1685, Jan 63; 19 pp incl tables and illus.
AF MPR 33-616-58-47, ONS Code 5110.22.011

Cartridge, Powder Actuated Cutter, KNS3, was developed
as a replacement for the explosive actuator in the MC-1
reefing line cutter used with heavy duty parachute as-
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- I. Cutter, Reefing Line
- II. Cutter, Powder Actuated
- III. Parachute, Aerial Delivery

- I. PA Report R-1685
- II. Farrell, J. M.
- III. AF MPR 33-616-58-47
ONS Code 5110.22.011

DISTRIBUTION LIMITATIONS:
None; obtain copies from DDC.

AD- ACCESSION NO.

FRANKFORD ARSENAL, Propellant Actuated Devices Division
Philadelphia, Pa 19137
DEVELOPMENT OF CARTRIDGE, POWDER ACTUATED CUTTER, KNS3,
FOR REEFING LINE CUTTER by J. M. Farrell
Report R-1685, Jan 63; 19 pp incl tables and illus.
AF MPR 33-616-58-47, ONS Code 5110.22.011

Cartridge, Powder Actuated Cutter, KNS3, was developed
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DEVELOPMENT OF CARTRIDGE, POWDER ACTUATED CUTTER, XM83,
FOR REEFING LINE CUTTER by J. M. Farrell
Report R-1685, Jun 63; 19 pp incl tables and illus.
AF MPR 33-616-58-7, GNS Code 5110.22.011

Cartridge, Powder Actuated Cutter, XM83, was developed
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3. Parachute, Aerial Delivery

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- II. Farrell, J. M.
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